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'Together we are stronger ?!' - Competition and synergies between Plant Functional Types in a changing precipitation regime in North Africa

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The timing and abruptness of vegetation decline at the end of the African Humid Period has been studied and debated by various working groups using a wide range of models and palaeo-proxy reconstruction approaches. There have been only few studies addressing the role of plant diversity in this context. We use a Dynamic Global Vegetation Model to investigate the potential effect of plant diversity on the abruptness of a vegetation collapse in an changing precipitation regime in North Africa. Ecologists agree that high biodiversity can have a stabilizing effect on ecosystems, especially under changing environmental conditions. However, it remains an open question how well plant diversity is represented in dynamic models that are widely used for studies on past climate changes and the consequences for ecosystems, and which competition and synergy effects determine the retreat of vegetation in aridification scenarios. Could high plant diversity have strengthened the ecosystem, facilitated plant growth and prevented an abrupt vegetation collapse at the end of the African Humid Period? Or could strong competition in a diverse environment have increased ecosystem resilience resulting in an abrupt vegetation collapse instead of a smooth decline?

We use the Dynamic Global Vegetation Model JSBACH to study the response of vegetation to a precipitation decline in North Africa. Diversity is represented by a set of Plant Functional Types (PFTs). To identify the effects emerging from different degrees of diversity, we perform simulations with different combinations of PFTs, prescribe atmospheric forcing and neglect feedbacks between land and atmosphere. First analyses show that vegetation retreats faster than the prescribed linear precipitation decline in all simulations. In comparison to single-PFT simulations, competition between PFTs limits in multi-PFT simulations the expansion and persistence of individual PFTs. The replacement of retreating PFTs by others that grow better under new conditions smooths the decline of total vegetation cover and buffers fast retreats of individual PFTs before the final breakdown.

The set of presented simulations provides the baseline for future coupled simulations that will account for the entire Earth System, including ocean, atmosphere, and land in its diversity.